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Development-Aid Supply Chains for Economic Development and Post-Disaster Recovery

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This study seeks to conceptualize supply chains that use funding from large donors or governments for long-term recovery following a disaster, or more generally, for economic development in a region. We call these development-aid supply chains (DASC) distinct from commercial or humanitarian supply chains. With little available formally on DASCs in the literature, we carried out a field study across five solar lantern supply chains in Haiti set up for recovery following the massive 2010 earthquake. Stakeholder resource-based view allowed us to use stakeholder theory, utility theory, and the resource-based view in analyzing how these supply chains work. We observed how donor cash in these supply chains brings together global original equipment manufacturers; national-level distributors; impact investors; microfinance institutions; retailers; and micro-entrepreneurs. Many of these entities are social enterprises that bridge development-minded donors with commercially oriented retailers and micro-entrepreneurs. The result of these bridging efforts is the flow of goods, cash, and social impact data. Our conceptual model flags the problem that donor funding, while crucial for reducing deprivation in the short term, may increase the dependence on aid rather than reduce it.

Key words: economic development; humanitarian disaster recovery; poverty alleviation; social enterprise; Stakeholder Resource-Based View; supply chain
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1. Introduction

Many people worldwide face extreme chronic poverty, in part due to war or natural disasters. The United Nations (UN) Sustainable Development Goal (SDG) 1 seeks to end poverty in all its forms everywhere. SDG 8 aims to promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all. For regions such as post-2010-earthquake Haiti, with only 44% of the population having access to electricity, SDG 7—seeking to ensure access to affordable, reliable, sustainable, and modern energy for all—is also relevant (World Bank, 2020). Governments and international charities or development agencies make funds available to provide products and services to the people affected while hoping to generate enough economic activity to eventually do away with the need for any aid.

Humanitarian supply chains bring products and services to the people displaced or otherwise affected by disasters. The supply chains needed are different when donors or governments seek to strengthen the local economy and "reduce dependence on external support" (Kretschmer et al., 2014: 996). Such supply chains offer researchers opportunities to build new theories about how multiple stakeholders, including donors and beneficiaries, come together to make a supply chain function. Like the need to develop a "science of humanitarian logistics" (INSEAD, 2016), we need a science of supply chains for post-disaster recovery or, more generally, economic development. As a starting point for theory building for such a science, this study seeks to conceptualize *development-aid supply chains* (DASCs).

We used the Stakeholder Resource-Based View (SRBV) (Sodhi, 2015) as our theoretical lens to complement the resource-based view with stakeholder theory, and for normative analysis, utility theory. We carried out our fieldwork in Haiti, which was impoverished further by the disastrous 2010 earthquake. The study comprised a multi-case study approach (Eisenhardt, 1989, Yin, 2018) of five supply chains of solar lanterns to consumers. Understanding the entire system's functioning requires studying all its components (Holguín-Veras et al., 2012, p. 494). Therefore, we sought to understand DASCs as functioning supply chains comprising nodes and flows with materials, information, and money flowing through a set of

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supply chain stakeholders (Carter et al., 2015). Using cross-case analysis, we developed a composite view across all supply chains to bring out the various elements for our conceptualization. We thus provide an understanding of what DASCs are and present a conceptual model for how such supply chains might help donors meet their two objectives for economic recovery or development: reducing deprivation and reducing dependence on aid.

Our findings reflect how different categories of supply chain participants with diverse objectives came together in the supply chains we studied, with donors playing a central role in seeking development by reducing both deprivation and dependence on aid. Global original equipment manufacturers (OEMs), national-level distributors, retail chains, and micro-entrepreneurs created material flows from sourcing to the beneficiaries in these solar lantern supply chains. A big part of the ecosystem pertained to cash-for-information flows; besides donors, there were impact investors, microfinance institutions, and others who accepted funds to provide social impact information in return. The flows of cash, information, and materials between the DASC participants helped satisfy their individual needs. These donors wanted to reduce deprivation, the beneficiaries wanted cheap and clean lighting and power, and the micro-entrepreneurs wanted an income opportunity. Many of the organizations in the DASCs were social enterprises that played a bridging role between donors and commercial supply chain partners. They used funds from donors to source products and worked with commercial or social enterprise partners for distributing these goods through micro-entrepreneur vendors. Overall, DASCs reduced deprivation in the region with necessary goods for beneficiaries, livelihoods for micro-entrepreneurs, and supply chain or retail capability in the community. However, as our conceptual model indicates, aid-based supply chains exist because of aid and could, therefore, further entrench dependence rather than reduce it. Many questions arise on reducing the dependency in the long run, and these require further research.

In the rest of the study, Section 2 provides some pertinent streams of the supply chain literature and this study's contribution to these streams. Methods and materials are the focus of Section 3, with the findings in Section 4. Section 5 provides our conceptualization of DASCs based on the results with testable propositions, and Section 6 concludes with a discussion and ideas for further research. Appendix provides the interview protocols that we used.

2. Literature

There are related topics in the operations literature but not specifically about supply chains created to recover or develop an entire region or country with development aid. The following streams in the literature are relevant to our work:

2.1. Supply Chain Conceptualization

The extant supply chain literature has examined partnerships and non-commercial interactions in particular organizations' commercial supply chains serving low-income customers (Hahn and Gold, 2014) and humanitarian supply chains (Beamon and Balcik, 2008, Oloruntoba and Gray, 2006, Pettit and Beresford, 2009). In *commercial supply chains*, a fundamental assumption is that participants in the supply chain (other than end customers) seek to maximize profit and create a sustained competitive advantage (Holcomb and Hitt, 2007, McIvor, 2009). In *humanitarian supply chains*, profit is absent from the objective function (Tomasini and Van Wassenhove 2009) because end users typically do not pay for the products and services they receive (Beamon and Balcik, 2008, Oloruntoba and Gray, 2006, Pettit and Beresford, 2009). Also, humanitarian supply chains are time-bound projects. For *DASCs*, including for longer term recovery following disasters as in Haiti, while one goal is to reduce the worst aspects of poverty, the other goal is to build economic self-sufficiency. Products and services are sold, not donated, to low-income individuals at subsidized prices due to donors. Importantly, DASCs seek to generate local economic activity and, like commercial supply chains, aim at reducing or eliminating the need for aid in the long term. (Kretschmer et al., 2014). By conceptualizing DASCs, we contribute to the broad supply chain literature that has thus far focused only on commercial or humanitarian supply chains.

2.2. Economic Development

In the economics literature, a fundamental question is the benefit of aid. Clemens et al., (2012) have reviewed and replicated the significant studies on the effectiveness of aid as the subsequent growth of gross national income (GNI), using "country" as the unit of analysis and aid as a percentage of GNI. They find empirical evidence suggesting that "on average—[across] all countries, over many decades, and regardless of the regression specification—aid has had a modest positive effect on growth" (p.614). We contribute by focusing on one possible means of deploying aid, that is, with DASCs, with the unit of analysis being the DASC and not the country. Our work allows for benefits to be relatively fine-grained and broad compared to just the growth of GNI. Our conceptual model shows *how* aid can reduce deprivation while still not reducing dependence on aid. Moreover, our conceptual model provides a starting point to further research on reducing dependence, which the empirical economics

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literature does not. There is also the operations literature on government subsidies and other poverty reduction programs using supply chains, for instance, in agriculture (Alizamir et al., 2019). Sodhi and Tang (2014) have considered economic recovery in flood-prone areas in Southeast Asia with micro-entrepreneur vendors. Yu et al., (2020) have analyzed "optimal" subsidies for development in supply chains. We contribute to this literature by formalizing the concept of DASCs.

2.3. Socially Responsible Operations

Some of the literature on commercial supply chains deals with alleviating poverty (Sodhi and Tang, 2016, White et al., 2011) or addressing institutional voids in low-income markets (Parmigiani and Rivera-Santos, 2015). There is also the social sustainability literature centered on the (western) corporation promoting social responsibility in developing country suppliers (Gold et al., 2013, Huq, Stevenson, and Zorzini, 2014), partnering with non-commercial entities like NGOs (Dahan et al., 2010, Hahn and Gold, 2014), or purchasing from bottom-of-the-pyramid producers (Mahapatra et al., 2019). Such literature recognizes stakeholders beyond buyers and suppliers (Gualandris et al., 2015), believing that managers in the corporation must deliver on social responsibility (Matos and Silvestre, 2013, Silvestre, 2015), not just profits. Still, the focus is generally on a single organization's supply chain. We expand this literature with a broad canvas highlighting donors' role in impacting an entire region with multiple supply chains rather than a single organization's socially responsible supply chain.

2.4. Social Enterprises with Supply Chains

Social enterprises can orchestrate supply chains to help alleviate poverty by meeting specific needs (Dillard et al., 2013, Hall and Matos, 2010, Lee and Tang, 2018, Pal and Altay, 2019, Pullman et al., 2018, Sodhi and Tang, 2011). We contribute to this literature by highlighting a very different role that social enterprises can play other than being the focal organization even though the aim of poverty reduction—mainly using micro-entrepreneurs—remains the same. In the present DASC context, the role social enterprises play is to bridge the development goals of the donors and income or profit goals of retailers and micro-entrepreneurs.

2.5. Humanitarian Supply Chains

The humanitarian supply chain literature focuses on getting much-needed goods and services to people right after a disaster. Here we are looking at supply chains that, besides supplying needed goods and services, aim to strengthen the local economy and reduce dependence on external support (Kretschmer et al., 2014: 996). Thus, we complement the emerging literature on humanitarian supply chains focusing on long-term recovery rather than immediate relief following a disaster (Çelik's 2016, Ibrahim and El Ebrashi, 2017, Sodhi and Tang, 2014). Although there is the common goal of reducing deprivation in the near term for both humanitarian and DASCs, our work brings out the critical difference of seeking—successfully or not—to eventually reduce dependence on aid.

Overall, we contribute to the supply chain literature broadly, theorizing on supply chains comprising donors, social enterprises, and commercial actors, driven by the donors' development agenda. Research on such supply chains can help governments and international NGOs meet the UN SDGs by co-creating such supply chains with social and commercial enterprises.

3. Methods and Materials

3.1. Theoretical Lens

Similar to Mahapatra et al., (2019), we use the Stakeholder Resource-Based View (SRBV) (Sodhi, 2015) to investigate DASCs. SRBV builds on the resource-based view (RBV), which researchers use to conceptualize commercial supply chains in the empirical supply chain literature. SRBV adds elements of stakeholder theory used in the sustainability literature and of utility theory used in the analytical literature.

SRBV is useful as a theoretical lens to study DASCs for two reasons. *First*, it allows us to accommodate the variety of stakeholders we expect to find in DASCs, including donors, commercial companies, and low-income consumers. *Second*, SRBV provides for the different ways the stakeholders develop and use resources and capabilities to enable flows that meet their respective utilities. These ways include, for instance, providing grants and leveraging networks of micro-entrepreneurs to get what they want from the supply chain.

SRBV serves as "a previously identified theoretical framework" that "can provide insight, direction, and a useful list of initial concepts" (Corbin and Strauss, 2008, p. 41) for our analysis of DASCs. Under SRBV, we consider stakeholders "whose utility depends significantly" on the operations. Each stakeholder "is treated on par with other stakeholders from a research perspective regardless of power and material differentials." The utility of these stakeholders "refers to preferences among choices with uncertain outcomes." SRBV allows researchers "to focus on and differentiate stakeholder-specific drivers of effort" (Sodhi, 2015, p. 1381–82), which helps us to analyze how DASCs work in terms of each stakeholder's resources and capabilities (Sodhi, 2015, p. 1382).

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Resources are the "tangible and intangible assets a firm uses to choose and implement its strategies" under RBV (Barney, 2001, p. 54). *Capabilities* enable organizations to "integrate, build, and reconfigure" their resources to survive in dynamic environments (Teece et al., 1997, p. 516). In the present context, capabilities help individuals survive poverty (Sen 1983, 1988, 2006). SRBV does not treat resources and capabilities differently in general, and, accordingly, our study clubs them together as "resources and related capabilities." However, as noted in the concluding discussion (Section 6), it is vital to study the two separately, especially if the goal is to reduce dependence on aid and eliminate it eventually. If so, development aid should target building resources in the short term and capabilities in the long term.

3.1.1 Research Question and Research Objectives. Our *research question*—what are DASCs, and how do they work?—translates to three *research objectives*: (1) Who the stakeholders are along with the resulting flows between, (2) what their utility preferences are, and (3) what their resources and capabilities are. Finally, to meet this study's aim, we need a fourth research objective: (4) How do all these elements work together for such a supply chain to run or even exist in the first place?

3.2. Research Design

We conducted a multi-case study (Eisenhardt, 1989, Yin, 2018) of five supply chains, the *unit of analysis* being the supply chain as a whole rather than a particular actor. We are studying a supply chain phenomenon about which little prior literature exists to our knowledge. As such, we chose the case study method to discover concepts and previously unidentified relationships between them (Eisenhardt, 1989, Eisenhardt and Graebner, 2007). Also, the case study approach allowed us to ask questions about a real-world phenomenon—DASCs—in the "natural setting" (Voss et al., 2002, p. 197). Furthermore, using *multiple* cases enables us to verify that our findings were not "simply idiosyncratic to a single case" but rather "replicated by several cases" (Eisenhardt and Graebner, 2007, p. 27). Therefore, our research replicated relationships between concepts across these multiple cases to ensure external validity (Voss et al., 2002).

3.3. Research Setting

We chose supply chains for solar lanterns sold to low-income consumers in Haiti. Here, donors have funded different participants in the supply chain for economic recovery following the disastrous 2010 earthquake. Solar lanterns help households reduce deprivation by meeting the basic need for lighting in homes and replacing kerosene. Using kerosene for lighting is expensive and causes harmful indoor pollution with carbon monoxide and dioxide. Therefore, solar lanterns have financial, health, and environmental benefits (Chaurey and Kandpal, 2010, SolarAid, 2014). The solar lanterns are sold, not donated, through micro-entrepreneur networks to support local commerce to realize economic self-sufficiency (Bardouille, 2012, Graf et al., 2013, Miller, 2009). Thus, Haiti provided us an ideal setting to study DASCs. Also, we had senior professional contacts in Haiti, which enabled us "to open doors where necessary" to access key informants (Voss et al., 2002, p. 206).

3.4. Overall Approach

We followed case study analyses of humanitarian supply chains (e.g., Dube et al., 2016) and grounded theory research principles (Corbin and Strauss, 2012). Our research process was iterative: We analyzed data as we collected it and used it to inform further data collection. We theoretically sampled cases within this setting (Eisenhardt, 1989) using the World Bank's Lighting Global list, which had 46 such companies in December 2016. Lighting Global is a "platform supporting the sustainable growth of the international off-grid lighting market as a means of increasing energy access to people not connected to grid electricity" (The World Bank & International Finance Corporation, 2016). The list has companies that make approved, high-quality solar lanterns and solar home systems.

We conducted Internet-based research on the 46 companies on the Lighting Global list and identified four OEMs selling solar lanterns in Haiti: (1) d.light, (2) Greenlight Planet, (3) Nokero, and (4) ovSolar. A fifth OEM, Ekotek, not on the Lighting Global list, was identified later for its reputation for high-quality products and social mission.

3.5. Data Collection

We collected data through interviews, fieldwork in Haiti, and archival research.

3.5.1 Interviews. We conducted 82 semi-structured interviews with 78 different supply chain stakeholders for the five products (Table 1). We interviewed informants over three successive rounds using interview protocols (Appendix):

1. Between late 2014 and mid-2015, we contacted experts from Africa, Asia, and Haiti, by phone regarding solar lanterns and home systems. These informants included CEOs and co-founders of the companies that made the products in our study, who would have a deep understanding of the whole supply chain, from

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Table 1 Informants for our Study

Categories	Informants
Product Companies	Co-Founder, Solar Lantern and SHS company
	Founder & CEO, Solar Lantern Company
	Senior Manager, Solar Lantern and SHS Company
In-Country Importers/Distributors	Founder & CEO, Haitian Social Enterprise SME
	Co-Founder and CEO, Haitian Social Enterprise
	Executive Director, Haitian-US Social Enterprise
	Project Director, Large Haitian Financial Services Company
	Project Director, Multinational Corporation Social Enterprise Subsidiary
Retail Stores	Sales Associate 1, Haitian Company A
	Sales Associate 2, Haitian Company A
	Sales Associate 3, Haitian Company A
Micro-Entrepreneurs and End Users	Micro-Entrepreneur Retailers and End Users of Solar Products in Case Study Supply Chains (n = 23)*
	Micro-Entrepreneur Retailers of Competing Products† (n = 22)
Donors	CEO, International Foundation A
	Project Director, International Charity A
	Project Manager, International Foundation B
	Senior Manager, International Charity B
	Sector Specialist, Multilateral Development Bank
Impact Investors	Associate Director, Impact Investment Fund A
	Senior Associate, Impact Investment Fund A
	Director, Impact Investor B
Microfinance Institution	Senior Manager, Microfinance Institution A
Expert Informants	CEO, International Water and Sanitation Social Enterprise
	CEO, Solar Technology Supplier in Haiti
	CEO, SHS company in India
	Chairman & Co-Founder, SHS Company in Southeast Asia
	Co-Founder & CEO, Solar Lantern & SHS Company in India
	Co-Founder & CEO, Mini-grid Company in Haiti
	Director, Charity Consulting Organization
	Director, East Africa MFI
	Founder & CEO, Solar Lantern Distributor in Africa
	Founder & CEO, Supplier to Solar Product Companies
	Manager, Large Street Market in Haiti
	Senior Advisor, Mature SHS company in India
	Senior Manager, International Health Charity

*All micro-entrepreneur in our study also owned and used the products they were selling.
†Competing products include low-quality solar lanterns, kerosene lanterns, candles, and cell phone charging services.

manufacturers to in-country distribution and sales. We asked these expert informants questions related to their expertise. Their answers helped us anticipate topics to cover in future interviews and confirm or clarify what we had found in previous interviews. Additionally, we identified essential stakeholders of supply chains for solar lanterns in Haiti during this first round of interviews. For example, Kiva and USAID emerged as providers of subsidized investment and grants, respectively, to some of the supply chains for solar lanterns (and solar home systems) in Haiti.

2. In the second round of phone interviews in Spring 2016, we targeted supply chain stakeholders identified during the first round of interviews, including NGOs and donor agencies, in-country distributors, and impact investors. In each interview, we asked what the stakeholder contributed to the supply chain and what they received in return. We also asked who they interacted with—who they bought from, sold to, donated to, borrowed from, partnered with, etc., and if they received any particular type of funding from whom.
3. It became clear that fieldwork was necessary to interview the micro-entrepreneur vendors who sell to the end customers in Haiti. These vendors are the critical "last mile" link of the supply chains. Interviews with these stakeholders, along with others based in Haiti, constituted the third round of interviews we conducted in our fieldwork.

We recorded all interviews and transcribed them.

For the second and third rounds of interviews, we had to overcome some challenges. *First*, we had to overcome the language barrier for our fieldwork in Haiti. The native language is Haitian Creole, so we used a certified translator to translate interviews

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in real time. *Second*, we worked with our translator to develop a culturally sensitive and polite way when approaching and speaking with micro-entrepreneurs in Port-au-Prince. For example, we would comment on the variety of items available for sale from the different vendors in the market. We would then explain our visit's purpose and request permission to ask questions and record the answers. *Third*, there was the challenge of ensuring safety, and our translator guided us to avoid areas of Port-au-Prince considered unsafe for non-Haitians because of the perceived threat of armed robbery. Still, we were able to capture end user perspectives from our interviews with micro-entrepreneur retailers themselves, who owned the lanterns they were selling.

We did not include the suppliers to the contract manufacturers or even the contract manufacturers supplying to the global OEMs in our study. The contract manufacturers, typically based in China or India, sell widely and do not have a particular "stake" in the supply chains we studied, except for Nokero. The same applies to the steel or solar panel suppliers of these contract manufacturers.

3.5.2 Fieldwork. We conducted our fieldwork over two weeks in August 2016, interviewing in-country distributors and the micro-entrepreneur retail vendors of solar lanterns sold through the five supply chains in our study (n = 23 vendors). We also interviewed vendors of competing products of low-quality lanterns (n = 22). All micro-entrepreneur vendors themselves owned solar lanterns or home systems, so we could also ask them why they purchased the product and what impacts it has had on their lives. Interviews with these micro-entrepreneurs were short, ranging from around 15 to 25 minutes—in one case, only 3 minutes—as we met them during working hours in street markets. We conducted enough interviews until we noticed significantly "diminishing returns" to our knowledge from each additional interview with the retail vendors (Voss et al., 2002, p. 210).

3.5.3 Archival Data. Before and during our fieldwork in Haiti, we conducted extensive archival research of Internet sources like press releases, industry blogs, organization web pages, and research reports by reputable organizations. We did this to identify additional supply chain stakeholders of interest for our study and triangulate data that we had received from the interviews to ensure internal validity (Yin, 2018). Using archival information to triangulate with data from our field observations and interviews in Haiti was especially crucial for the Ekotek supply chain to identify relevant stakeholders and to ensure the validity of what we were learning from our interviews.

Collecting data from three different sources strengthened the robustness of our research. We were able to refine our interview protocol during each successive round of interviews, particularly to probe "emergent themes" further (Eisenhardt, 1989, p. 539). We were also able to triangulate across data sources for confidence in the collected data's objectivity and reliability (Voss et al., 2002).

3.6. Data Coding

We coded the interview-and-archival data during and after each round of data collection at two levels:

-*First-order categories*: Having identified stakeholder groups across multiple supply chains in our study, we deductively coded our data for the resources, capabilities, and utility preferences for each stakeholder group using the *a priori* concepts from SRBV. We then used inductive coding to identify first-order concepts within these codes. Our interest lay in how stakeholder resources, capabilities, and utility preferences affected supply chain flows. As such, we paid close attention to instances when informants and archival sources mentioned how a particular stakeholder interacted with other stakeholders, for example, by giving a grant to an OEM. The interaction shows that the OEM's activities were supporting the donor's stated social mission.
-*Second-order categories*: We then developed higher level categories by organizing concepts with similar "properties and dimensions" (Corbin and Strauss, 1990, p. 7). For example, we grouped the concepts of "covering costs," "retaining customers," and "aiming at economic viability" that emerged within the codes of utility preferences into a second-order category we called "Commercial Sustainability."

We used each successive round of data coding to validate the categories and the relationships between them that had emerged from the inductive coding earlier (Eisenhardt, 1989). The authors discussed each code and emergent category to agree on their respective meanings, relationships, and fit with the data. We also triangulated between interview data and archival materials during the coding processes, prioritizing categories that appeared in multiple sources (Jick, 1979) and across the five supply chains in our study. This iteration between our data, the identified categories, and the relationships between these categories enabled us to form robust underlying arguments that contribute to theory building (Eisenhardt, 1989).

3.7. Analysis

Our results build on within-case and cross-case analyses, although we refer to their composite. The within-

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case analysis enabled us to "become intimately familiar with each case as a stand-alone entity" (Eisenhardt, 1989, p. 540). We identified the stakeholders involved in each case, their resources and objectives (utility preferences), and how they worked together to create a functioning supply chain. We constructed maps of each such supply chain, showing the flows or interactions between stakeholders, thus providing insight into how a DASC operates.

Cross-case analyses helped us understand whether and how first-order concepts and second-order themes apply to the different cases. These analyses prevented overemphasis of any one aspect, improved groundedness, and enhanced the findings' generalizability (Dube et al., 2016, p. 50). In within- and cross-case analyses, we focused on the stakeholders involved in the DASC, their resources and capabilities, and their utility preferences to understand the flows of materials, information, and money. We also sought to explain how a donor uses DASCs to reduce deprivation and dependence on aid using the different stakeholders' activities as concepts. The result was a conceptual model with testable propositions.

4. Findings

We present the results corresponding to our first three research objectives in Sections 4.1 (supply chain stakeholders and the supply chain flows between them), 4.2 (the stakeholders' utility preferences), and 4.3 (their resources and capabilities). A conceptualization of how DASCs work, the fourth research objective, follows in Section 5.

4.1. Supply Chain Stakeholders and Flows

OEMs in our supply chains were companies based in the United States and India that bought solar lanterns from Chinese contract manufacturers and sold products to low-income countries worldwide. Importers and distributors were the in-country partners for the OEMs. All but one OEM (Vistle Group) and all but one importer (Total Haiti) were social enterprises (Table 2).

The typical supply chain's material flows had importers and distributors sourcing solar lanterns from the global OEMs. Retail chains and stores, in turn, bought solar lanterns from importers and distributors and sold them to consumers or micro-entrepreneur vendors. The micro-entrepreneur vendors in the "last mile" bought solar lanterns from the retail networks of importers and distributors and sold them to consumers. On the finance side, donors varied from private foundations and charities to multilateral development organizations. Impact investors provided financing to social enterprise organizations along the supply chain. Microfinance institutions provided small loans to the micro-entrepreneur vendors.

Overall, stakeholder groups 1-5 (Table 2) interact with the supply chains through the physical movement of finished products, information, and money in the usual supply chain sense. Stakeholder groups 6-8 are the donors in this study. They provide direct financial support to the supply chains through grants, donations, and subsidized investment (social impact investment and microfinance) in return for social impact data.

Supply chain flows represent the movement of materials, information, and cash that scholars use to describe the flows along a supply chain (Carter et al., 2015, p. 90). We focus only on the flows necessary to the supply chain's functioning—the solar lantern material flows, the social impact data information flows, and the cash flows, including cash payments or subsidized money as microloans, impact investment, or grants for cash flows. Figures 1–5 depict these flows for the five OEMs' supply chains, respectively, and Figure 6 provides a composite depiction.

The **material flows** common to all five supply chains were the flows of finished goods: solar lanterns (and solar home systems). The **financial flows** of importance were grants, donations, and subsidized investment through social impact investment and microloans. These flows aimed at ensuring that the low-income targeted beneficiaries could afford the final retail sales prices. As one CEO told us, *"The price we could sell them for was not sustainable, because if you take into account all of the costs [. . .] they are essentially subsidized."* (Exec. Dir.,

Table 2 Stakeholders in All Five Supply Chains (see also Figures 1–5)

Stakeholder group	Stakeholders identified during data collection
1. Social enterprise OEMs	d.light; Greenlight Planet; Nokero; ovSolar; Vistle Group (Ekotek)
2. Importers and distributors	EarthSpark Enèji Pwòp; MicamaSoley; Palmis Enèji; RE-VOLT; Sogexpress; Total Haiti
3. Micro-entrepreneur vendors	CARE Entrepreneurs; Enèji Pwòp Entrepreneurs; Fonkoze Entrepreneurs; RE-VOLT Entrepreneurs; Sogexpress Vendors
4. Retail stores	EarthSpark Stores; Total Gas Stations; Sogexpress Stores
5. Consumers/end customers	Solar Lantern Customers; SHS Customers
6. Donors	Ashden; CARE; Christian Aid; Kiva; EarthSpark Nonprofit; Entrepreneurs du Monde; Fonkoze Foundation; Gates Foundation; Global BrightLight Foundation; Global Giving; Global Partnerships; Greater Good Haiti; Global Sustainable Electricity Partnership; GSMA; IABD; IndieGoGo; Scaling Off-Grid Energy; Shell Foundation; State of Colorado; United Nations; USAID; US Patent Office; UKAID; World Bank
7. Impact investors	Acumen Fund; Arc Finance; Bamboo Finance; Energy Access Ventures; Kiva; Oikocredit; Omidyar Network; Overseas Private Investment Corporation; Yunus Social Business
8. Microfinance institutions	CARE Village Savings and Loan Associations (VSLA); Fonkoze; Palmis Mikwofinans Sosyal

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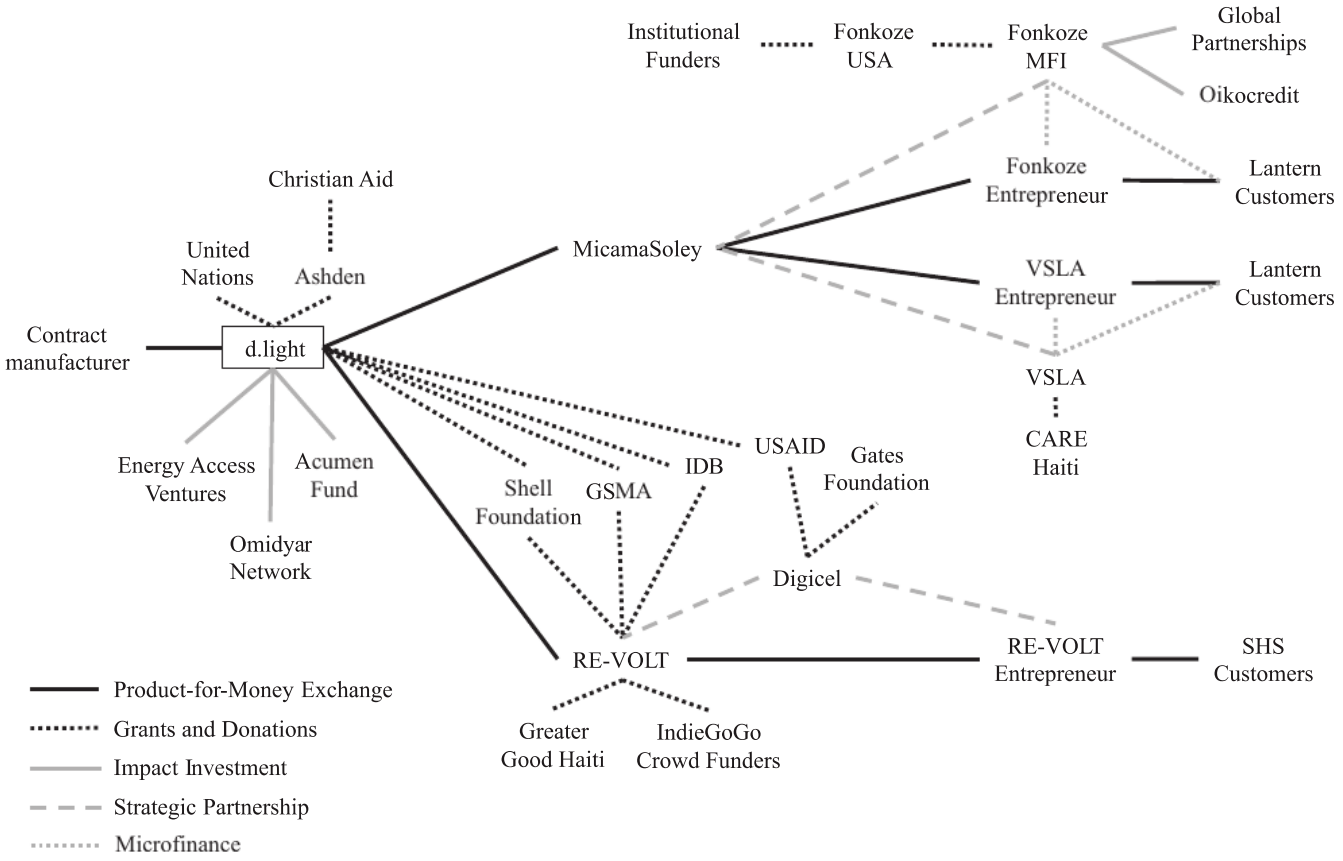
Figure 1 Stakeholders and Flows for d.light



Haitian-US social enterprise). The lanterns' final retail prices then amounted to US $10-$20, often paid in small monthly installments over time. The donors' cash also maintained social impact investors and microfinance institutions, as would be the case from profits sustaining supply chain participants in a commercial supply chain. **Information flows** in the DASCs include many types of information, including the solar lanterns and the interest rate on a microfinance loan. However, the crucial information flow we identified was what our informants described as quantifiable data about **social impact data** (SID). These data comprise information about how the target beneficiaries, low-income Haitians, had improved their well-being by interacting with the supply chain. For example, beneficiaries save each month by not having to purchase kerosene. SID serves as evidence of an organization's contribution to development, which they could then "sell" to donors for further grants and impact investors for subsidized investment.

4.2. Stakeholder Utility Preferences

We next analyzed stakeholders' objectives or, in SRBV terms, utility preferences and identified three high-level categories of utility preferences (Table 3):

- *Commercial sustainability* related to maximizing profit, such as retaining customers and covering costs, and, in the long run, avoiding overreliance on grants
- *Social sustainability* related to alleviating poverty in society, for example, by supporting the local economy and improving the well-being of low-income households
- *Household economic sustainability* comprised ways by which individual households sought to survive in poverty conditions; for example, by purchasing a solar lantern to provide light at night or to charge their mobile phones. Or, as with micro-entrepreneurs, households sought economic sustainability through selling solar lanterns to earn money.

These objectives illustrate how DASCs are a hybrid supply chain with profit-minded actors—as in any commercial supply chain—and development-minded actors with beneficiaries' survival objectives as in any humanitarian supply chain. Different categories of stakeholders pursued other goals. Contract manufacturers and retail stores exhibited a *commercial sustainability* utility preference. End customers (beneficiaries) were the only stakeholder group with *household economic sustainability* utility preferences. Micro-

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Figure 2 Stakeholders and Flows for Greenlight Planet

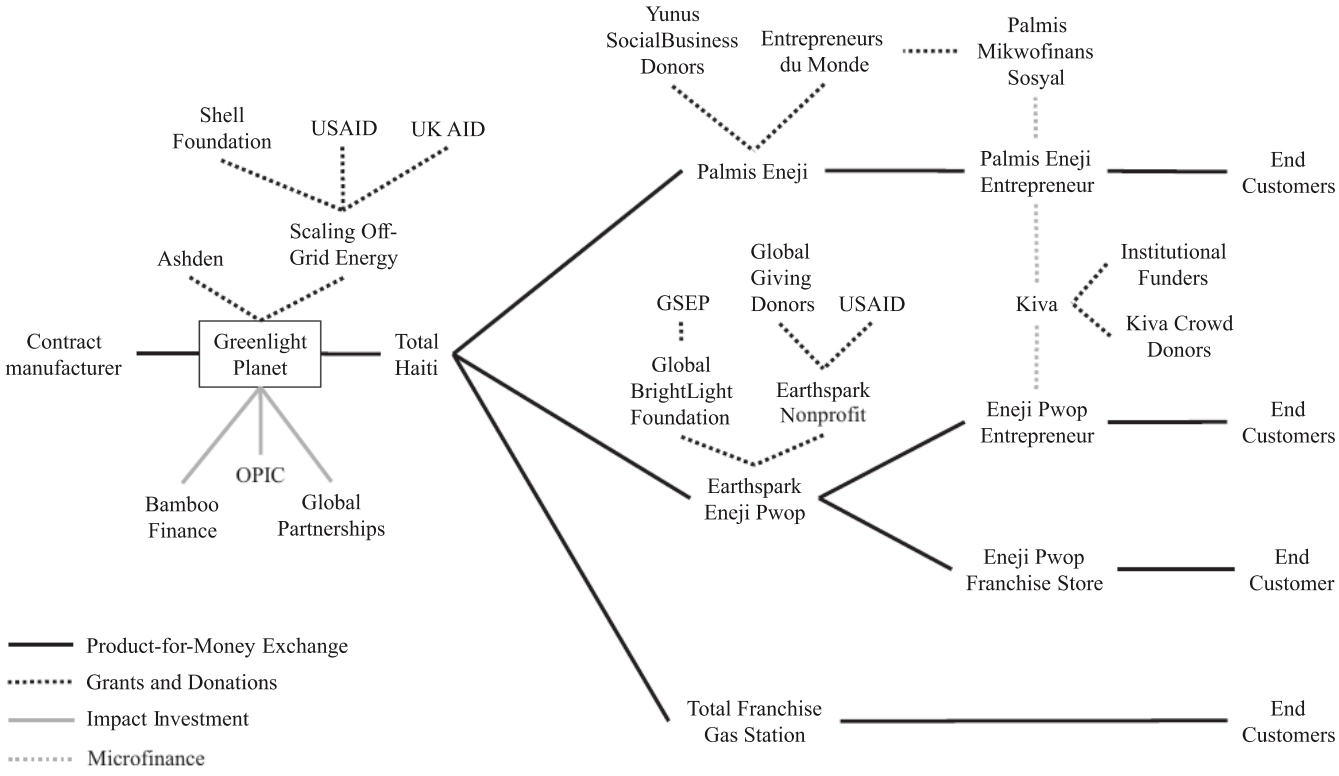
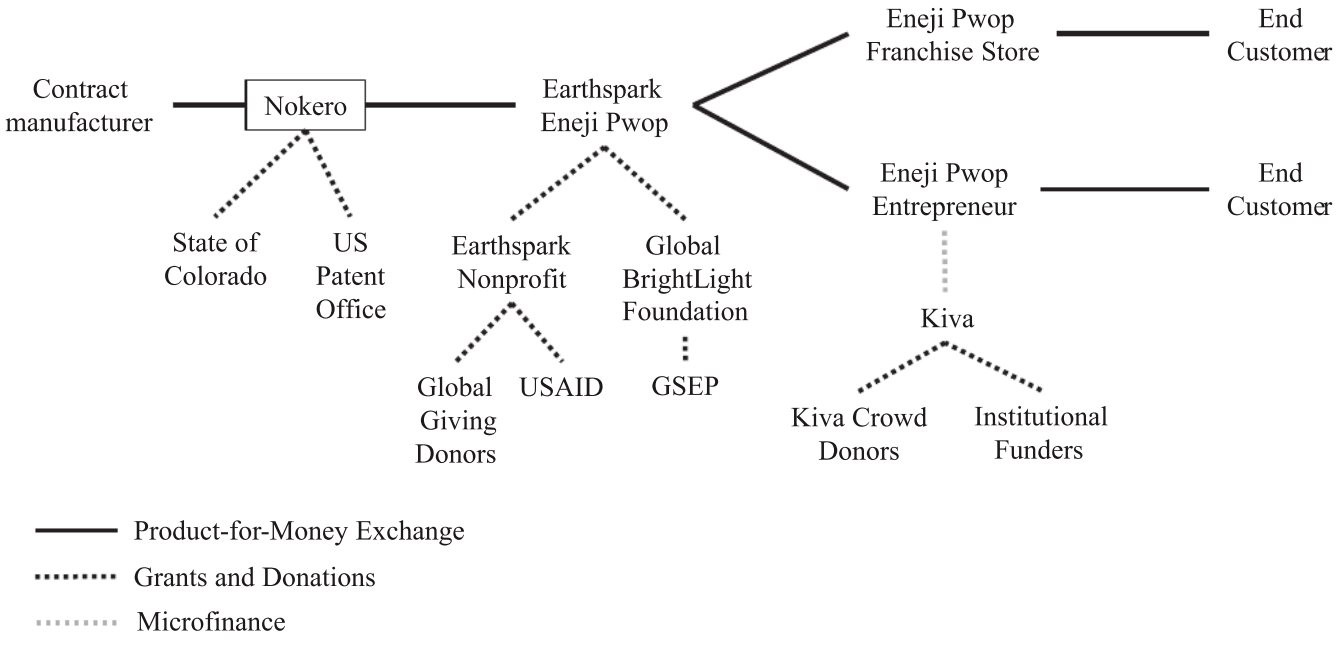


Figure 3 Stakeholders and Flows for Nokero ("no kerosene")



entrepreneur vendors had both *commercial sustainability* (related to their entrepreneurial activities) and *household sustainability* (related to earning money for their families) utility preferences. Donors had purely *social sustainability* utility preferences. Many donors also had *environmental sustainability* goals—not covered in our study—as seen from their respective websites. Some of the social sustainability preferences also reflect

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Figure 4 Stakeholders and Flows for ovSolar

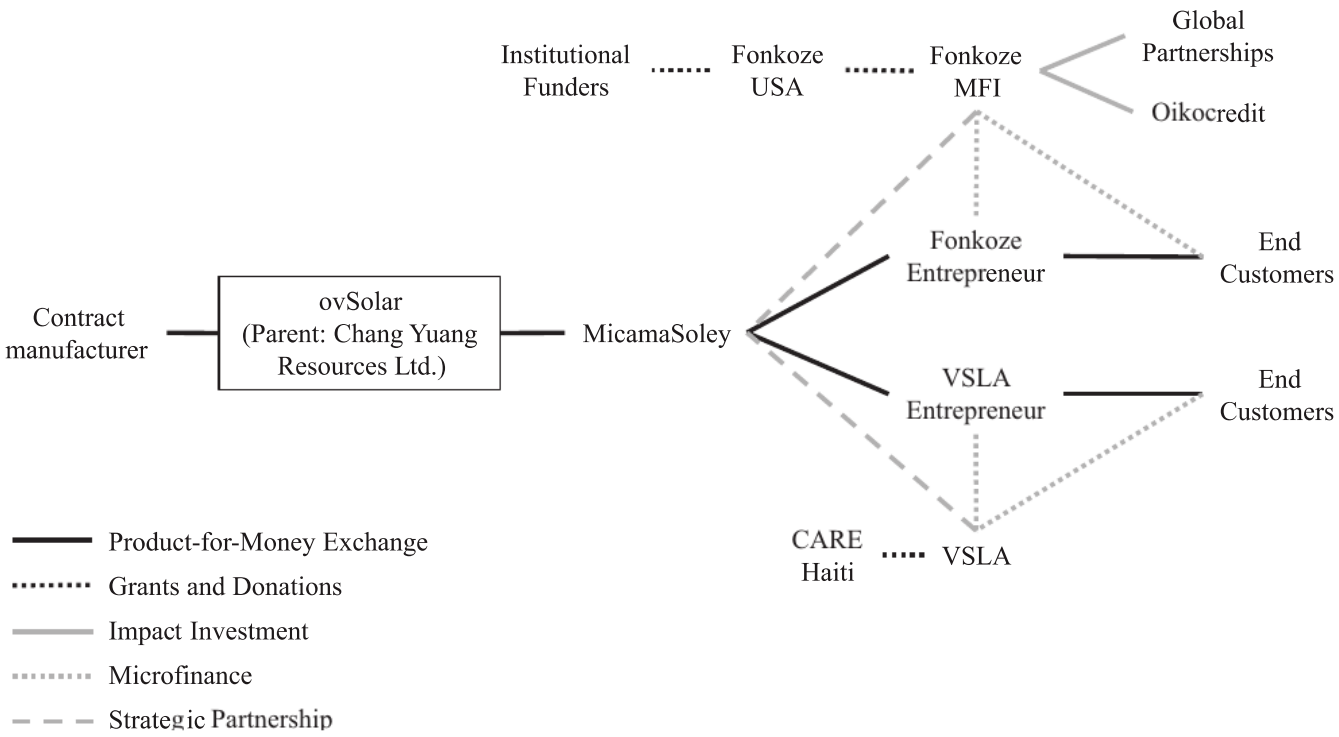
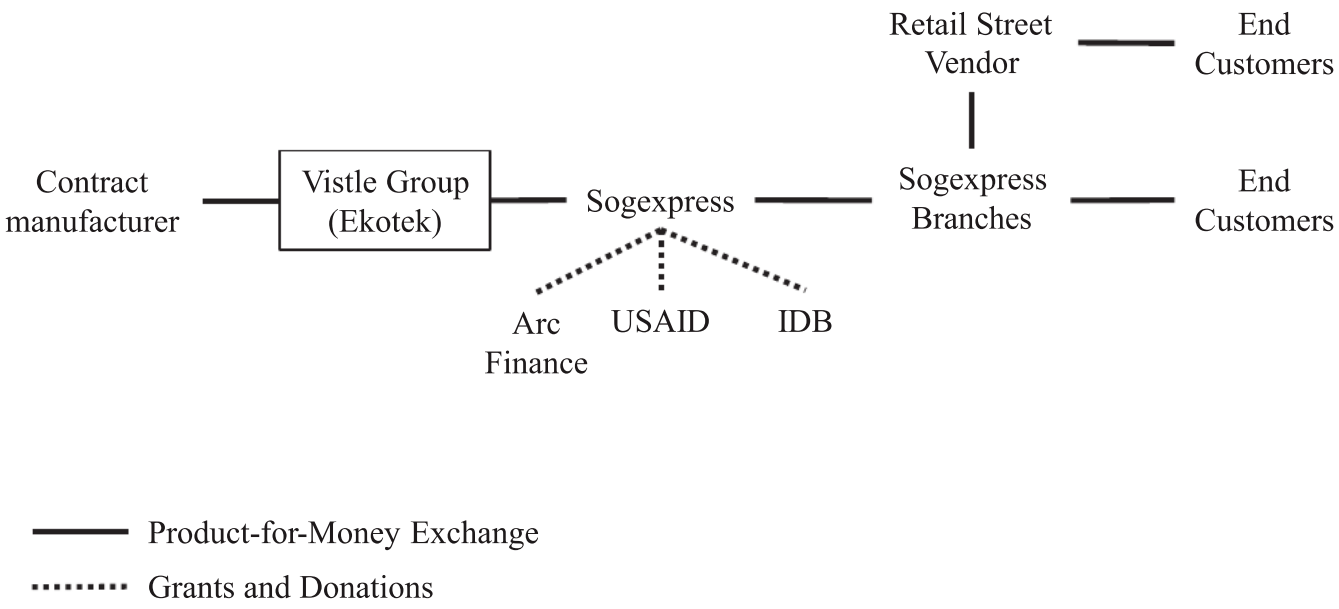


Figure 5 Stakeholders and Flows for Vistle Group (Ekotek)



environmental sustainability goals, such as replacing kerosene, a fossil fuel, with a renewable energy source using solar energy (Table 3).

4.2.1 Social enterprises' mixed preferences. Four stakeholder groups held *both* commercial and social sustainability objectives. These are product companies (the OEMs) and the in-country importers or distributors who move products. Microfinance institutions that lend to micro-entrepreneurs are also social enterprises. Impact investors who provide subsidized funding to supply chain stakeholders are yet another category of

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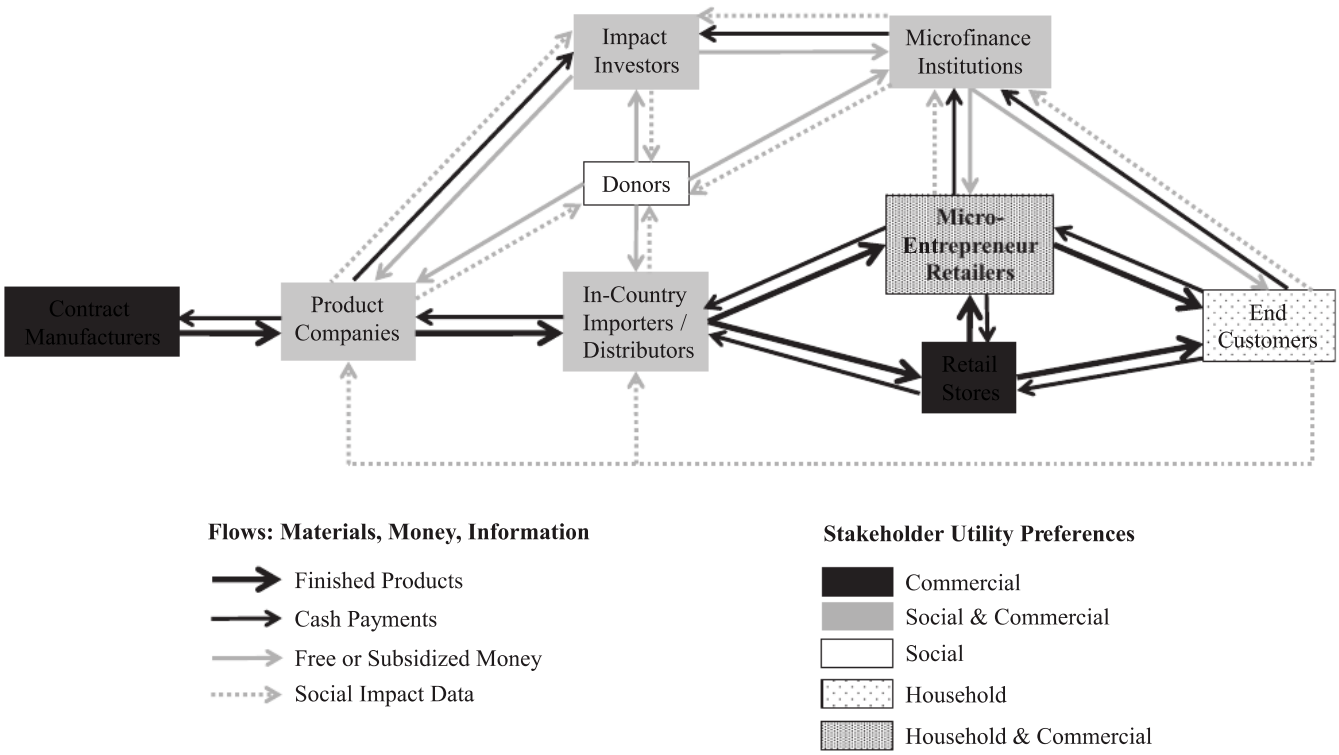
Figure 6 How DASCs Work—a Flow Model



social enterprises. Organizations in these groups sought to maximize both utility preferences:

> *"It's a business that is both social and commercial. The double goal is very important to [our organization]. We make this a business, and we ensure its social impact by providing solar technology solutions not just to the end customers but also to NGOs."* (Project Director, Multinational Corporation Social Enterprise Subsidiary)

By pursuing commercial and social utility preferences through the organization's core activities, stakeholders in these four groups satisfy the definition of a social enterprise: An organization established primarily to address a social problem while earning revenues to sustain itself financially (Battilana and Lee, 2014, Besharov and Smith, 2014, Dacin, Dacin, and Tracey, 2011). These organizations play an important bridging role between the socially driven donors and the commercially driven supply chain participants such as retailers.

4.3. Resources and Capabilities

For most stakeholders, the resources and related capabilities are straightforward. For donors of any type, one resource is the money allocated for development initiatives and the ability to find "like-minded partners" that can put the donors' money to distributing needed goods and provide credible social impact data. Likewise, the social enterprises develop resources (1) to seek donors to get money in return for credible social impact data and (2) to use their money to fund the manufacture and distribution of desired goods that appeal to donors. The retail stores must find importers (or distributors) to buy the products and consumers to sell. The micro-entrepreneurs themselves must be able to source products (and apply for microloans) to sell and serve their customers well. The end customers must pay the (subsidized) price for these products and use them effectively.

These social enterprises are central to the overall functioning of DASCs with their unique resources and capabilities. Social enterprise OEMs source high-quality products to help low-income customers meet basic needs. They operate distribution channels that are central to the supply chain. Overall, these social enterprises have developed resources to support the flows of materials, information, and money necessary for the DASC to function. We identified the following higher order (second-order) resource categories from our analysis of resources and related capabilities:

> Sourcing and selling high-quality products that reduce the conditions of poverty
> Managing a distribution channel to support the local economy via micro-entrepreneurs

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Table 3 Stakeholder Utility Preferences (Objectives)

Second-order categories	First-order concepts	Examples of supporting quotes
Commercial Sustainability	Covering costs/earning a margin	"There are costs linked with these activities, in terms of production, transportation, logistics, marketing [. . .] that must be covered by the sales price of lanterns." (Project Director, multinational corporation social enterprise subsidiary)
	Retaining customers	"Also, it is an anti-churn device. What does anti-churn mean? The customer would stay with us instead of going to [our competitor]" (Co-founder and CEO, Haitian social enterprise)
	Avoiding overreliance on grants	"We can't be taking grants solely to operate. We have to be able to stand on our own." (Senior Manager, microfinance institution)
Social Sustainability	Provide access to electricity	"What we do as providing clean energy solar solutions to communities that are underserved in the sense of being unelectrified" (CEO, international foundation)
	Eliminate kerosene	"I would like it to work. I would like to be able to eliminate kerosene. Because I think kerosene is evil." (CEO, Haitian SME)
	Help local market mitigate vulnerability	"For donors, it is about building the market." (Senior Manager, solar lantern and home systems company)
		"We are focusing on vulnerable women and detecting social injustice, poverty, and vulnerability." (Project Director, international charity A)
Household Economic Sustainability	Household Health and Safety	"People do not have to worry about their house catching on fire if they fall asleep. Also, the kerosene hurts the eyes of kids often, so this would help with that. That is the point of selling these lanterns." (Sales Associate, large Haitian financial services company)
		"What motivates me: the lamp is good for everything. For blackouts, for a person who just had a baby — it is good for multiple things: charging phones, playing music, saving money on candles." (Solar lantern end customer and micro-entrepreneur retailer)
	Household savings	"Families that are using kerosene lamps or torches or batteries, which use a reasonable portion of their income, will buy solar light. And it is an investment; they tend to recoup the cost within ten weeks, and the lights last 2–4 years, so from then on in, they are saving a lot of money." (Associate Director, impact investment fund)
	Household income	"Selling these lanterns is a way to make money. Let's say, I make 300 (Haitian) dollars. I will use a 100 for food, and then have 200 to bring home to my family." (Solar lantern user and micro-entrepreneur vendor)

Collecting social impact data and packaging it for donors.

We discuss each resource in turn.

4.3.1 Sourcing and selling high-quality products that reduce conditions of poverty. The product companies and in-country distributors participated in these supply chains by offering high-quality solar lanterns or solar home systems to reduce the beneficiaries' deprivation. Product quality was of particular importance to stakeholders with social (or social and commercial) sustainability objectives. A low-quality lantern that did not work well or broke after only limited usage eroded the financial and other benefits meant to accrue for beneficiaries. *"Even if the product is very affordable, [and you can] get a new one every six months, that defeats the purpose."* (Project Director, multinational corp.'s social enterprise subsidiary).

The social enterprise product companies and in-country distributors developed specialized resources and accompanying capabilities to produce, buy, and sell a high-quality, poverty-reducing household solar product with a commercial aim. Simultaneously, their social objectives led them to ensure that the products were affordable and of high quality. These products were not cheap, and the various stakeholders recognize the importance of the funds:

> *"We would not be able to sell at the price we're selling if it weren't for <Donor 1>, <Donor 2> and <Donor 3]. [. . .]. [The donors] gave us money for marketing, and to help us spread the word about the negative impacts of kerosene and the like." (Snr Manager, Large Haitian Importer/Distributor)*

Let us briefly consider each of these resources (**Table 4**):

1. These social enterprise product companies developed *relationships with manufacturers of high-quality solar products*. Each of the three product companies we spoke with had very close relationships with their contract manufacturers.
2. The social enterprise product companies and in-country importers had *warranties* on their products, which allowed end customers to return a faulty product and receive a functioning one, ensuring the desired social impact of owning a high-quality solar product. Warranties were available only for the products sold by social enterprises. By contrast, when asked about warranties, vendors of lower

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quality solar lanterns replied "no" or "the customer can try it when they buy it—if it does not work, they can choose another one."

3. The social enterprise product companies (OEMs) developed *innovative features* for their solar household products. Importers/distributors sought such features, for instance, a built-in radio or the ability to charge a cell phone. Product innovation boosted demand for the products, the importers and product companies earned more and recorded more social impact.
4. These product companies and in-country importers had in-depth knowledge of translating product use into social impact data, or SID. The most common benefits were financial savings and improvements to health and safety. The product companies used this knowledge when designing the products and the importers when selecting products. Both types of social enterprises used this knowledge to inform their social impact data collection (**Table 4**).

4.3.2 Distribution channel that supports the local economy. In-country distributors set up distribution channels in a way that helped reduce poverty. They did so by promoting local economic activity via the channel or selecting channel partners with social sustainability objectives. We identified two resources:

1. The first resource was an *extensive network of micro-entrepreneur vendors*, many of whom were women. The importers in our study actively targeted and developed networks of micro-entrepreneur retailers. Typically, they worked with a microfinance organization that provided microloans to female borrowers or by leveraging networks of micro-entrepreneur vendors of other products. Using micro-entrepreneurs creates income-generating possibilities and social impact data and is a crucial aspect of development, besides providing beneficiaries with lighting.
2. The distributors' second resource was the relationships with, and access to, *existing distribution infrastructure* such as local retail chain stores. To "piggyback" on this existing infrastructure, the social enterprise importers had to find the right partners for whom selling household solar lanterns would benefit their business. One example was the mobile phone companies' outlets. These companies had extensive reach from rural villages to big cities throughout Haiti. For mobile phone companies, selling solar household products alongside mobile phones and airtime top-up cards helps because solar products helped their customers charge their phones (**Table 5**).

The network-based distribution channel that leveraged micro-entrepreneur retailers enabled in-country importers and the product companies who did not have a physical presence in Haiti to reach the "last mile" beneficiaries, that is, low-income customers. Product companies sought out in-country importers

Table 4 Producing and Selling High-Quality Products that Reduce Deprivation

Resource	. . .and related capabilities	Example quotes
Relationship with a manufacturer of high-quality products	Identifying and building relationships with manufacturers, negotiating prices, testing products	"It's a mixture between having a high-quality product, forming a relationship with the manufacturer, testing them in-country to see how well they are accepted, and then negotiating prices." (Executive Director, Haitian-US Social Enterprise) "They are good quality and have a guarantee. If you buy one of the cheaper lanterns, you don't get a guarantee, so if it breaks, you can't return it." (Micro-entrepreneur reseller for Haitian Social Enterprise)
Product quality with warranty	Collecting, repairing, or replacing broken products via a network of resellers	"I want to see a proper working prototype. What does that mean? By sitting with the Chinese manufacturers and going through the product, [I want to] get to a stage where we can [. . .] get the product to the market." (Co-Founder and CEO, Haitian Social Enterprise)
Innovative functionality to meet market demand	Prototyping directly with manufacturers, testing prototype in the market	"We have these lamps that resolve the problem of the blackouts, of kerosene, of candles, problems with fire and with toxic fumes." (Project Director, Large Haitian Financial Services Company)
Knowledge of product impact on poverty	Learning about how the product can improve end users' well-being	"There's a suggestion around the quality of life or well-being or opportunity to socialize and spend time together with family and friends, which dim lighting doesn't really encourage. And then I think the last one is health and safety, in terms of accidents. There are a lot of incidents with children drinking kerosene and being poison because it's often sold in soda bottles in the market. And kerosene lamps are flame-based, and so they will get knocked over and start fires." (Snr, manager, Impact investor)

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that had access to a network of resellers, as a senior manager at an OEM explained:

> *"We're working with < importer>... They order from us and then do distribution – leveraging some of < local company's> network, so a lot of the guys who work for them are guys from <the local company>... Or, some of the distribution points are the same where they have <local company> resellers. So, they're leveraging...the existing infrastructure.* (Senior Manager, solar lantern and home system company)

Selling the solar household products through micro-entrepreneur networks enabled the product companies and in-country importers to sell more products to low-income households. The micro-entrepreneur retailers increased their commercial sustainability as well as their household sustainability:

> *"Selling these lamps helps me support my family. The money that I make permits me to support my family and get the kids to school. When people buy from you, you are able to make a little bit of money to support your family. Also, since I have the lamps, I don't use any other lights like candles or kerosene."* (Micro-Entrepreneur Retailers of Solar Lanterns)

Each stakeholder could maximize its respective utility preference using micro-entrepreneurs, materials, information, and money along the supply chains. An aid organization could have bought solar lanterns from an OEM, distributed them using their employees, and donated them to low-income households as in a humanitarian supply chain. In that case, no additional local economic activity would take place. Supporting local economic activity through the product and distribution companies was crucial for the donors:

> *"We are working in difficult environments, but when you meet the micro-entrepreneurs, you see the amount of poverty alleviation that these companies can have long term is absolutely fantastic."* (Senior Manager, International Charity B)

Therefore, such channels are another way that the product and distribution could demonstrably create social impact as social enterprises.

4.3.3 Collecting and packaging social impact data for donors. We were surprised to see the different grants, donations, and subsidized investment flowing into the DASCs at various echelons without any apparent coordination (Figures 1–5). Funds were being given upstream in the supply chain to product companies and social impact investors and downstream to the microfinance institutions and micro-entrepreneurs within the same product's supply chain. The flow of free or subsidized money ultimately made the solar lanterns more affordable for the beneficiaries and sustained the different organizations and micro-entrepreneurs.

The social enterprises had to demonstrate they were eligible to receive donations or subsidized funds by demonstrating their ability to reduce poverty. One informant at a donor organization described this requirement as *"we want partners that share the social mission"* (Project Director, International Charity A). The donors' preference for partnering with social enterprises as product or distribution companies was in line with the ongoing trend for donors supporting market-based activities (Cooney and Williams Shanks, 2010): *"There was already a shift towards, for example, taking a market approach"* (Senior Manager, International Charity B). Collecting social impact data and reporting it to donors was often onerous for product companies and in-country distributors:

Table 5 Distribution Channel that Supports the Local Economy

Resource	...and related capabilities	Example quotes
A large network of mostly female micro-entrepreneurs	Recruiting and training female micro-entrepreneurs	"If you don't include women in the distribution channel, your distribution will not reach [...] the people that it needs to reach." (Expert Inforto sellCEO, Solar Lantern Distributor in Africa)
Relationships with and access to existing distribution infrastructure	Facilitating relationships, financial flows, and product flows throughout the network.	"The village agent does distribution across their VSLA [i.e., savings]. The role for [us] is often mediation between VSLA and the private sector partner. [...]. What you have to do is to ensure the market for the private sector importing the solar lamps." (Project Director, International Charity A)
	Identifying opportunities where leveraging existing distribution infrastructure benefits the organization that set up the channel.	"In terms of distribution [...] I piggyback off of existing [large Haitian company] agents. We have quite a close relationship with [the large Haitian company]. They are good agents, and then I also piggyback on their [local shops]. [...]. My supply chain is very intertwined with them." (Co-Founder and CEO, Haitian Social Enterprise)

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> *"Now, basically, when you are getting grants, you are an open book. You have to report activations, and you're getting hit – like, why are your activations lower this month and against your budget. It is like a board [of directors] that you're up against."* (Co-Founder and CEO, Haitian Social Enterprise).

As a result, the social enterprises we interviewed had developed capabilities to record social impact data to present it to donors (Table 6).

Therefore, all the social enterprise OEMs and distributors published their social impact on their websites (Table 7).

5. Conceptualizing Development-Aid Supply Chains

We combined the five DASCs in our study to get a composite flow diagram comprising the stakeholders of interest here—the donors, the OEMs, and in-country importers/distributors who are social enterprises, retailers with a network of micro-entrepreneur vendors, and end customers. The links depict flows of materials, information, and cash between them. These links emphasize the bridging role played by social enterprises in this DASC. Each stakeholder's utility depends directly on the flows that it receives and sends to other stakeholders and indirectly on the flows between other supply chain stakeholders, which gives any stakeholder a "stake" in the supply chain (Figure 6).

5.1. How Development-Aid Supply Chains Work

Now we ask the fundamental question underlying the identification of the components of DASCs and their interactions: *how DASCs work*? The crucial difference between a DASC and an ordinary (commercial) supply chain is the development aid, which results in supply chain participants with resources very different from those in a commercial supply chain. Below, we make four observations about the functioning of DASCs to help us with conceptual modeling:

1. *Donors and their funds play a central role in DASCs*. Most participants in the supply chain depend directly on the funding that eventually comes from the donors. It is hard to envisage the existence or continuation of the supply chain without this funding. The product's material flows occur like most commercial supply chains from the contract manufacturer to the OEM on to the importers/distributors and then to the micro-entrepreneur retail network, and finally to the end customers/beneficiaries. However, supply chain flows would not occur if end customers could not afford the product and if the micro-entrepreneurs and the retailers cannot afford the stocks or make positive profits. So, aid is necessary for a DASC to function.
2. *Most links in the DASC are based on cash-for-information transactions*. The fact that donors play such a vital role in such supply chains is hardly surprising—humanitarian supply chains exist only because of donors and governments. However, the ecosystem of mostly cash-and-information-only links in DASCs is quite different from humanitarian or commercial supply chains (Figures 1–5). Financial flows occur from the donors and the social enterprises in exchange for credible social impact data to measure the aid's effectiveness. The social enterprise could be the OEM, the importer/distributor, the impact investor, or the microfinance provider. Microfinance institutions give loans to micro-entrepreneurs and receive repayments as in any commercial loan arrangement. However, in the present context, the microfinance institutions received funding from impact investors in exchange for information from the micro-entrepreneur vendors about how microloans contributed to their income generation. Overall, there is a great deal of complexity in the financial flows, as seen from the five case studies. This ecosystem of organizations and links across them in the supply chain reinforces the previous observation about donors' funds being central to the functioning of DASCs.
3. *Social enterprises play a key bridging role in the creation and running of DASCs*. OEMs and distributors/importers are crucial to the functioning of any supply chain. However, the OEMs and distributors in DASCs are quite different from those in ordinary supply chains, maybe necessarily so. They must have a social mission that resonates with the donors' social sustainability goals and commercial preferences to interact with purely commercial players like

Table 6 Collecting and Packaging Social Impact Data for Donors

Resource	. . .and related capabilities	Example quotes
Data on positive social impact directly resulting from social enterprise's activities	Collecting and disseminating social impact data	"We have this system called MIS, the Monitoring Information Systems, where every month we collect data directly from the <OEM> related to solar lamps. . . At the end of June, I will have the report. We will then report the progress of the social enterprise back to the donors." (Senior Manager, International Charity A)

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Table 7 Social Enterprise OEM Impact Reporting and Corresponding Donor Statement

OEM impact reporting	Donor providing free or subsidized money
d.light: *"84 million lives empowered; 22 million school-aged children reached with solar lighting..."* (http://www.dlight.com/social-impact/, accessed August 14, 2018)	Shell Foundation: "Our aim is to apply entrepreneurial thinking to catalyze new ways to deliver lasting public benefit. [...]. This means working to create social enterprises..." (http://www.shellfoundation.org/Our-Approach, accessed August 14, 2018)
Ekotek: *"... impact of the programs so far, including the sale of over 86,000 EKOTEK solar devices, benefitting more than 430,000 people, and the creation of thousands of jobs for solar entrepreneurs."* (http://ekotekenergy.com/projects-home/, accessed August 14, 2018)	Arc Finance: "Arc Finance provides financial support to microfinance and other financial institutions, in addition to energy/water enterprises, to both spur product innovation and to support business incubation" (http://arcfinance.org/the-arc-approach/, accessed August 14, 2018)
Greenlight Planet: *"5,525,352 off-grid homes reached; [...] 25% increase in household income; 94% families feel safer with Sun King"* (https://www.greenlightplanet.com/mission/, accessed August 14, 2018)	Scaling Off-Grid Energy: "Our vision is to spur a vibrant marketplace of enterprises that provide off-grid energy solutions" (http://www.scalingoffgrid.org/scaling-grid-energy, accessed August 14, 2018)
Nokero: "*Nokero's products add three or more hours of increased income productivity per day.* [...]. *The cost of an N233 is equivalent to the monthly fuel expenses for a family of four.*" (https://www.nokero.com/, accessed August 14, 2018)	US Patent Office: "The program provides business incentives for reaching those in need [...]. The awards showcase how patent holders with vision are pioneering innovative ways to provide affordable, scalable, and sustainable solutions for the less fortunate." (https://www.uspto.gov/patent/initiatives/patents-humanity/learn-more, accessed August 14, 2018)
ovSolar*: "Over 2 million people at areas without electricity have benefited from ovSolar."* (http://www.ovsolar.com/ index.php?m=Article&a=show&id=98, accessed 14 August 2018)	World Bank Lighting Global: "We facilitate access to finance for manufacturers, distributors, retailers, and consumers." (https://www.lightingglobal.org/about/, accessed August 14, 2018)

contract manufacturers or retail networks. OEMs and distributors are by necessity social enterprises who seek funds to develop the resources and capabilities they need to build and distribute subsidized products through commercial participants in the supply chain. Microfinance institutions and impact investors are also social enterprises. They enable funds from donors to retailers and micro-entrepreneurs.

4. *The flow of funds builds resources and capabilities that enable flows*. For a commercial supply chain, RBV suggests that resources are why the supply chain network exists and flows occur. Similarly, SRBV explains why there are flows in a DASC—we have multiple stakeholders with different resources. Resources have to be built, especially in post-disaster contexts or where there were none for the supply chain to exist and operate. For development to occur—the goal of development aid—we need to consider *enablers*—the resources and capabilities—and *constraints* reflecting the lack of such resources or capabilities or inability to develop them. Donors seek to remove these constraints with their funds directly by improving liquidity or indirectly through people's training, reducing search costs, etc. From a donor's perspective, the distributor must already have, or be able to, develop sales channels to the last mile. The distributor must also build retail capabilities in micro-entrepreneurs through training. The distribution channels must also collect and process social impact data for sending back to the social enterprise product companies and eventually to donors. Such resources are critical for the different stakeholders regarding the partnerships they choose as resources along the supply chain, just as they would in a commercial supply chain as per RBV.

To recap, the social enterprises doing production and distribution enable flows in the DASC. They do so by developing resources for sourcing and distributing high-quality products for the poor, managing sales-and-distribution channels that also help decrease poverty, and collecting and processing social impact data for the donors. The supply chain flows then work as they would in any supply chain to meet the stakeholder-specific utility preferences. Similarly, the impact investors and microfinance institutions also play a bridging role between donors and the commercial players to whom they give microloans or grants.

5.2. A Conceptual Model of DASCs and Their Goals

To help set the theory-building stage for development-aid supply chains, we now offer some relevant concepts and their links as propositions for testing in empirical studies. Our purpose is to relate the donors' and the other stakeholders' activity level (Figure 6) to the donors' (and the supply chain's) eventual goals. We have the *funding activity of the donor* as one concept and two other concepts (1) *deprivation* in the community or society and (2) *dependence* on external support (Kretschmer et al., 2014: 996) that the donor seeks to

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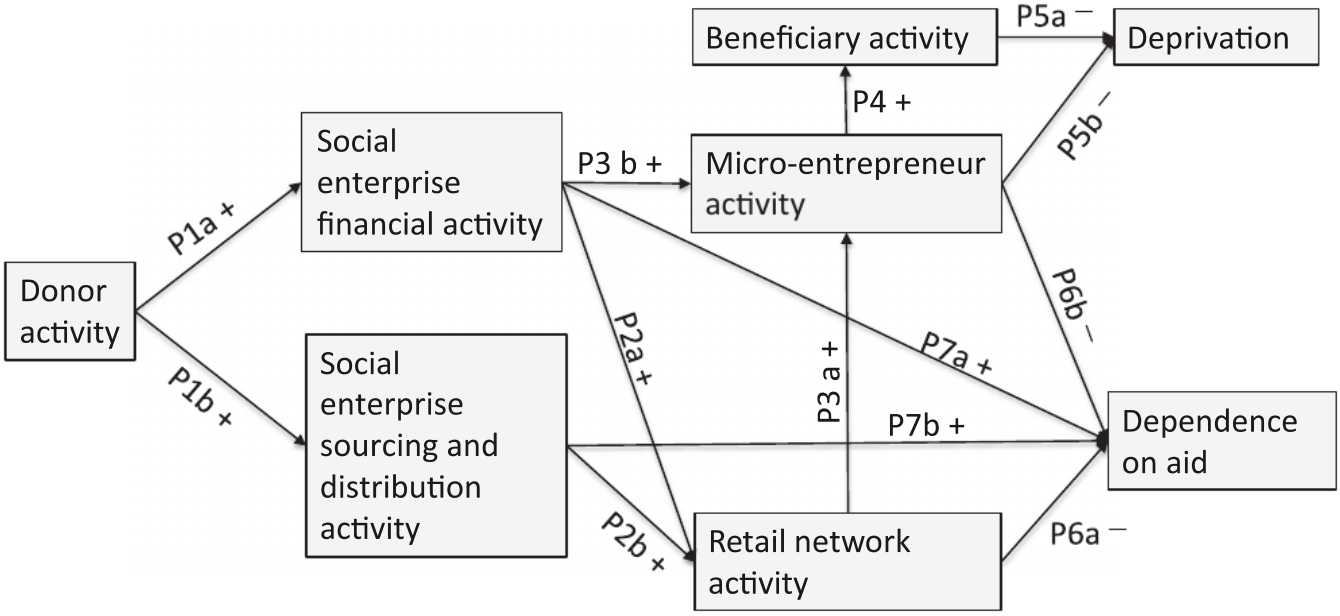
Figure 7 A Conceptual Model of How Donors Use DASCs to Achieve Their Goals of Reducing Deprivation and Dependence on Aid



reduce. In between, we have concepts related to the level of activities of (a) the financial, social enterprises, (b) the production/distribution social enterprises, (c) the *retail networks* (retailers, retail chains, and organizers of micro-entrepreneurs), (d) the micro-entrepreneurs, and (e) the beneficiaries or end customers. We offer the following **propositions** to link these concepts (Figure 7):

P1. Increased donor funding increases the social enterprises' (a) financial activity and (b) sourcing and distribution activity.

More funding attracts more social enterprises to step in. It also encourages existing social enterprises to increase their production and distribution efforts.

P2. (a) Increased social enterprise financial activity and (b) increased sourcing or distribution activity increases the activity of retail networks.

The retail networks get more liquidity from impact investors and microfinance institutions and can get more products from the importer or distributor.

P3. (a) Increased retail network activity and (b) increased social enterprise financial activity increases micro-entrepreneurs' activity.

As retail networks seek more outlets, they attract more micro-entrepreneurs, which can also sell more quantity.

P4. Increased micro-entrepreneur activity links to more beneficiary activity

More effort by micro-entrepreneurs leads to more beneficiary activity, which comprises new purchases and hence more use of the products.

P5. (a) Increased beneficiary activity and (b) increased micro-entrepreneur activity increase the reduction in deprivation.

More beneficiary activity possibly increased economic activity through cellphone charging, light, money saved on avoiding kerosene purchase, etc. More microeconomic activity means more income for these vendors as they earn profit from the sales of solar lanterns and other products.

P6. (a) Increased retail network activity and (b) increased micro-entrepreneur activity reduce dependence on aid.

Retailers and retail networks build resources and capabilities to carry out retail in any supply chain, whether development aid or commercial.

P7. Social enterprise activity, whether (a) financial or (b) sourcing and distribution, increases dependence on aid.

The social enterprises' complex ecosystem emerges solely to convert donor funds to reducing beneficiaries' deprivation. It does so by engaging with commercially minded retailers and micro-entrepreneurs. Most links are cash for social impact data, so the resources developed are not valuable for a commercial supply chain. As such, increased social enterprise activity engenders dependence.

Propositions P6 and P7 highlight the tension for a socially minded donor: reducing deprivation requires the use of means that increase dependence on aid.

6. Conclusion

Supply chains to support long-term recovery following disasters exist and are essential, but such supply chains had not been studied formally in the literature before. We carried out a field study of five supply chains of solar lanterns in post-disaster Haiti using the SRBV as

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our theoretical lens to conceptualize such supply chains. In these supply chains, we identified the stakeholders and their utility preferences, resources, and capabilities. In particular, as part of our findings on how DASCs work, we showed the central role that donors' funds and social enterprise OEMs and distributors play in enabling the supply chain flows. Our main conclusion, important from both theoretical and practical viewpoints, is that while aid enables flows in the supply chain to reduce deprivation, it also engenders an ecosystem dependent on assistance with many cash-for-information transactions.

6.1. Implications for Research

We have proposed a conceptual model to show how donors' funding makes DASCs work to help foster economic recovery by reducing deprivation and dependence. A natural question is how this model can incorporate different types of entities with diverse objectives, whether we need a more fine-grained approach to the entities in the model, and the implications for both.

6.1.1 Different Types of Entities with Different Objectives. For instance, we could ask if the model can explain a purely commercial supply chain without any donor entities or financial social enterprises. The path from the sourcing-and-distribution entity through the retail network to the micro-entrepreneur vendors would represent a purely commercial supply chain, indicating that it is possible to reduce deprivation without any aid and hence no dependence on it. So, why not just have purely commercial supply chains for development without any aid? Our model cannot answer that, but a multiple-stage supply chain would expose the consumer (beneficiary) to double marginalization, making it difficult for most consumers to purchase goods to reduce their deprivation.

6.1.2 Government Aid to Industry. Yet another supply chain could be one with a government donor but with no other financial institutions. Entire sectors such as aerospace and defense have depended on government subsidies even in advanced economies. Witness the calls in the United States from the industry in 2021 for the government to invest in electronic chip manufacturing. Thus, we would have a donor providing funds to a supply chain ending with the end customer filled with profit-maximizing entities. Rather than reducing deprivation, we could talk about maximizing revenues, but the question of dependence on government aid remains.

6.1.3 Different Types of Donors with Different Positioning. Regarding developing a more fine-grained model than what we proposed (Figure 7), note that we did not distinguish the donors' different roles or position themselves (Figures 1–5). Nor did we look for intended outputs other than deprivation and dependence. There are different types of donors. These include humanitarian organizations like CARE that also play the role of donor, potentially using cash-based assistance. There are also the more traditional donors like USAID and Shell Foundation, who position themselves differently in the supply chain. The various types of donors may have different impacts, requiring us to have a more fine-grained output than just *deprivation* or *dependence*. Furthermore, even the same kind of donors may follow different approaches and have a different impact, particularly in reducing the dependency on aid.

6.1.4 Relationships between the Entities and Their Diverse Objectives. We have glossed over at least five differences across the supply chains we studied: (1) One of the OEM companies—d.light—had two different importer partners in Haiti, the others had just one. (2) Vistle Group was primarily commercial, while in all other supply chains, the OEMs were social enterprises. (3) Greenlight Planet products' supply chain was the only one with a large multinational corporation as a distributor, the France-based Total's gas stations, and its social enterprise subsidiary, Awango. (4) Nokero's contract manufacturers in China were also equity shareholders in Nokero, whereas the four OEMs had standard contractual relationships. (5) ovSolar was the only OEM that had pivoted from completely unrelated business lines involving steel production to supplying solar lanterns. In contrast, the other four OEMs emerged specifically to sell solar household products to poor consumers in low-income countries. Given these differences, we need to consider the different utility preferences when private entities wholly or partly own the social enterprises in the DASC. Indeed, many large companies now have their own NGOs and social enterprises, and this study could be relevant in other contexts too.

6.1.5 Multiple Donors Working Independently. Along with there being different types of donors, the donors work independently at different parts of the supply chain. The absence of coordination showed up in the five supply chains, but our model does not capture it. Having different donors work thus can only increase the number of cash-for-information links and potential dependency. However, studying multiple donors this way would require a more fine-grained conceptual model and further study.

6.1.6 Normative analysis. Our work primarily uses the descriptive and instrumental aspects of SRBV

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to understand the effectiveness of DASCs in terms of the social impact. Any normative analysis would also require measures to improve, possibly motivated by social impact data collected in DASCs. For micro-entrepreneurs and end customers, Sen's (2006) work defines and measures poverty in terms of capabilities. An example of normative analysis is Yu et al., (2020), who characterize "optimal" subsidies motivated by this study's setting.

6.1.7 Capabilities and Resources. We used SRBV as our theoretical lens and did not closely examine resources (RBV) or capabilities (dynamic capabilities). A better understanding of reducing dependence may warrant extending the conceptual model by distinguishing effort into developing these separately. We also did not differentiate resources as being tangible or intangible or capabilities as being static or dynamic. While one could look at sustained competitive advantage driving decisions for some entities, external factors may also play an essential role in line with the industrial organization literature. For instance, it may well be that while resources are helpful in the near term for reducing deprivation, developing capabilities is better for weaning the beneficiaries off aid. Alternatively, it may well be that just removing constraints is enough to reduce both deprivation and dependence. Thus, capabilities and resources require further nuanced study.

6.1.8 Competing Products. We have discussed building resources or capabilities for selected products, but donors could be funding the destruction of resources and capabilities for competing products. For high-quality solar lanterns that we studied, competing products included kerosene lanterns, candles, and low-quality solar lanterns. The supply chains for their products did not receive donor support, so the micro-entrepreneur vendors suffered collateral damage and reduced their household economic sustainability. Destruction of the capability to make local products will increase dependence on aid even though the imported solar lanterns reduce deprivation. Our model needs to expand to cover this aspect.

6.2. Implications for Practice

Our study has practical implications for donors and for managers of social enterprises that participate in DASCs to make these supply chains work more effectively. For the first goal, that is, to reduce deprivation, donors must develop the resources (and capabilities) of the social enterprises, given their bridging role in the functioning of the DASC. The ability to collect credible data on the positive social impact is critical to the social enterprise's success, not only to generate further funds but also to direct effort to more rewarding areas. Not raising adequate funds would also impair the overall functioning of the DASC, so collecting social impact data is crucial.

At the same time, our conceptual model suggests that the means to reduce deprivation may well increase or at least not reduce dependence. Therefore, donors have to be especially conscious of achieving their second goal of reducing dependence. Simply tracing the paths of propositions in the conceptual model (Figure 7) suggests that not having the social enterprises for financial activities can potentially help in reducing dependence. Donors could ensure retailers, retail networks, and micro-entrepreneurs build long-term capabilities suitable for commercial supply chains from the outset. The commercial aspect of the DASC would be emphasized and lead to freedom from aid, but this requires further research.

Having many types of donors working independently from each other suggest a need for coordination to achieve both goals, rather than just deprivation. In Haiti, there are donors still working in the mode of humanitarian relief and focused solely on reducing deprivation.

6.3. Further Research

This study is a step toward theory building on DASCs. As seen from the above implications for research and practice, several limitations in our research offer further research opportunities:

1. *Donors*: We did not capture donors' perspectives, their different types, or their different approaches in any detail. Researchers must also seek donors' views on the endgame to see *how* they see dependence ending.
2. *Other supply chains, including those with government subsidies*: Our study covers only five solar lantern supply chains in Haiti in a recovery context. Researchers could study more DASCs with different products and services in other parts of the world with varying infrastructure readiness and governance structures. There are also many industrial supply chains such as aerospace and defense backed by government subsidies. Studies of supply chains of competing products in conjunction with DASCs for supported products would shed light on aid destroying capabilities.
3. *Metrics of success and normative use of the conceptualization of DASCs*: Further research could look into different, fine-grained metrics of success rather than deprivation and dependence, starting from social impact data. Field studies could measure how exactly aid is helping. Such metrics could help pave the way for the normative use of DASCs.

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4. *Corporate foundations*: Our study was about supply chains that are donor led. However, profit-making corporations with corporate social responsibility initiatives could conceivably play a role in furthering the UN SDGs by creating and participating in DASCs, making their extensive resources and capabilities available. Large companies are beginning to have foundations and social enterprises—as we saw with France-based Total in our study—that could consciously design DASCs and leverage small and micro retailers in the target beneficiary communities.

We hope researchers will find that DASCs opening up another front in the supply chain literature. Moreover, we hope companies, governments, and international NGOs will find such supply chains to help achieve many UN SDGs.

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Appendix

Interview protocols

In the sections below, we present the interview protocols for this study's three rounds of interviews.

Guiding Questions for Round 1 Interviews with Product Company CEOs

- What products do you make?
- How long has [company name] been in business, and have you always been [person's title]?
- Where are the products sold?
- Where are your headquarters?
- Why is your organization in this business in the first place?
- Who manufactures your products, and how did you select your manufacturer?
- Describe the supply chain, starting from the manufacturer in [country] all the way to the end-user in Haiti.
- Who are the key stakeholders of that supply chain?
- What does [key stakeholder mentioned] contribute to the supply chain, and what do they receive in return? [Repeat this question for the stakeholders that the informant mentioned in response to the previous question.]
- What would you say are your core strengths as an organization that enable you to produce and sell [solar lanterns or solar home systems] that are ultimately sold in Haiti?
- Where do your revenues come from?
- Have you received any grants, impact investment, or other subsidized financial capital? If so, what type of funding was it, who was it from, and what did the funder or donor want in return?

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- What do you look for when selecting organizations you work with—either as suppliers or distributors?
- Ultimately, what does your organization get in return for producing and selling [solar lanterns or solar home systems]?

Guiding Questions for Round 1 Interviews with Expert Informants

1. What is your experience with [the solar lantern/solar home system sector; poverty alleviation; microfinance; impact investment; social enterprises; Haiti]?
2. Why do you think donors and impact investors are interested in financially supporting organizations that make or sell solar lanterns and solar home systems?
3. What is it that holds the supply chain together when you have such a variety of types of organizations in the chain—commercial companies, donors, micro-entrepreneurs, distributors, product companies, manufacturers, etc.?
4. What do you think are the key stakeholders we should speak with along the supply chain for solar lanterns and solar home systems sold in Haiti?

Guiding Questions for Round 2 Interviews with Key Supply Chain Stakeholders

- How long has [company name] been in business, and have you always been [person's title]?
- Where are your headquarters?
- Why is your organization in this business in the first place?
- How and why did you partner with [stakeholder along the supply chain]?
- What do you contribute to this partnership, and what do you receive in return?
- Where do your revenues come from?
- Have you received any grants, impact investment, or other subsidized financial capital? If so, what type of funding was it, who was it from, and what did the funder or donor want in return?
- What do you look for when selecting organizations you work with—either as suppliers or distributors?
- What would you say are your core strengths as an organization that enable you to participate as a/an [insert their organization's role—for example, distributor, donor, impact investor, microfinance organization] in the supply chain for [solar lanterns or solar home systems] sold in Haiti?
- Ultimately, what does your organization get in return for participating in this supply chain?

Guiding Questions for Round 3 Interviews with Micro-entrepreneur Retailers of Solar Lanterns and Solar Home Systems

- What types of products do you sell?
- From whom do you buy the [solar lamps or solar home systems]?
- Do you have access to credit, either from a microfinance organization or from [the distributor mentioned in response to the previous question]?
- Who are your customers?
- Why did you start selling [solar lanterns or solar home systems]?
- How do you attract clients?
- How does selling the lanterns help you and your family?
- Do you own a lantern yourself? If so, how has the lantern impact you and your family?
- What do your customers like about the lanterns? Why do you think they buy them?
- What do you need in order to sell solar lanterns—in terms of personal skills and tangible things like money, a place to sell them, etc.?
- About how many lanterns do you sell per week?
- At what price do you sell the lanterns?
- Do you offer a warranty on the lanterns?
- What challenges have you faced in selling lanterns?
- How did you overcome [the challenge mentioned in response to the previous question]?

Guiding Questions for Round 3 Interviews with Micro-entrepreneur Retailers of Competing Products

- What types of products do you sell?
- From whom do you buy the [products]?
- Have you heard of [brand names of products in five supply chains being studied]?
- Do you have access to credit, either from a microfinance organization or from [the distributor mentioned in response to the previous question]?
- Who are your customers?
- Why did you start selling [products]?
- How do you attract clients?
- How does selling these products help you and your family?
- Do you own a solar lantern or solar home system yourself? If so, how has the lantern impact you and your family?
- What do your customers like about the products you sell? Why do you think they buy them?

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- What do you need in order to sell [products]—in terms of personal skills and tangible things like money, a place to sell them, etc.?
- [If selling solar lanterns or solar home systems:] About how many lanterns do you sell per week?
- [If selling solar lanterns or solar home systems:] At what price do you sell the lanterns?
- [If selling solar lanterns or solar home systems:] Do you offer a warranty on the lanterns?
- What challenges have you faced in selling [products]?
- How did you overcome [the challenge mentioned in response to the previous question]?

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